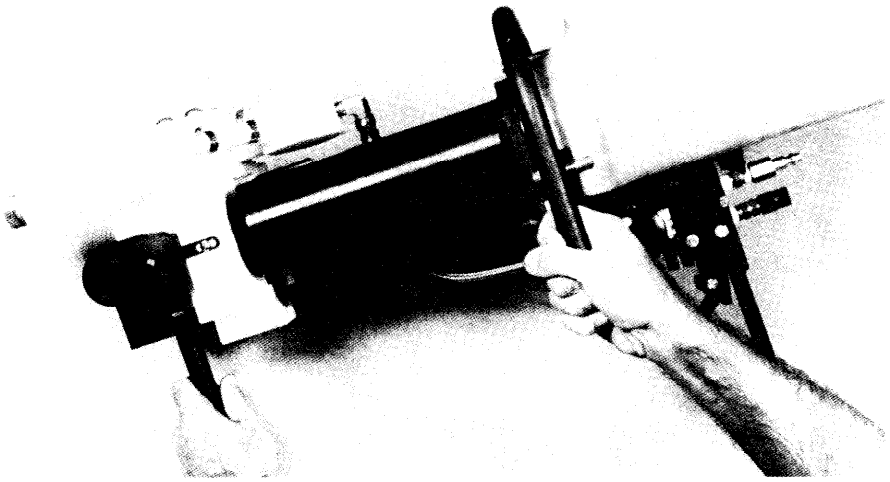
REMR TECHNICAL NOTE CS-MG-1.2
DIVER OPERATED GROUT DISPENSER



Prototype grout dispensing tool

PURPOSE: To provide information on the diver-operated epoxy grout dispenser, developed by the Naval Civil Engineering Laboratory (NCEL), for use in the installing of rebar anchor bolts in soft, porous coral and other materials underwater.

APPLICATION: Equipment and techniques for underwater application of epoxy grout by divers are frequently required in the construction, maintenance and repair of fixed marine and freshwater facilities. The dispenser provides an improved technique for the mixing and dispensing of epoxy grouts underwater, for use in embedding anchors in existing concrete structures, porous coral, and other materials.

ADVANTAGES: The dispenser allows underwater grouting operations to proceed at a repetitive rate of approximately 15 cycles/hr, dispensing 40 fluid ounces per cycle from 2 disposable cartridges. A cycle is defined by the time required to load, dispense, blowout and remove a cartridge. The blowout system was incorporated to prevent epoxy from clogging the tool internally. Holding capacities in excess of 40,000 pounds, for rebar grouted into concrete blocks with epoxy, can be achieved if proper installation techniques are used.

The two epoxy parts within the tool reduce maintenance, and disposable cartridges ease handling. This minimizes the safety hazards which are normally associated with the handling of epoxy and cleaning agents.

LIMITATIONS:

a. The tool requires pneumatic pressure of 100 psi over ambient for normal operation, or pneumatic power from an 80 to 120 psi air supply.

b. The tool operates at an underwater temperature of 60°F and above. At temperatures below 55°F, the resin components no longer flow. Radical increases in the viscosity of the resin compound can be seen between 65 and 45°F.

c. The dispenser weighs 35 pounds in air and 7 pounds in seawater unloaded, 43 and 8.5 pounds loaded with full epoxy cartridges. The low in-water weight of the tool itself, coupled with the effects of a neutral or positively buoyant supply hose makes the tool somewhat difficult to handle underwater. Using a negatively buoyant hose for approximately ten feet from the tool should partially alleviate this problem.

d. Cartridges to be used with the tool must be evenly filled, with care taken to insure that no large, trapped air bubbles are within the mass of epoxy. The cartridges should also be marked so that divers can identify the component of epoxy contained in the cartridge with a gloved hand when conditions of reduced underwater visibility hinder identification.

e. Proper dispensing techniques should be stressed. All holes must be filled from the bottom up to displace the water in the hole with the dispensed epoxy.

PERSONNEL REQUIREMENTS: A trained and qualified scuba diver is required to operate the grout dispenser. A short introductory lesson for proper and efficient operation of the tool is the only dispenser-related training required.

EQUIPMENT DESCRIPTION: The major components of the grout dispenser are the static mixing tube, ram-controlled metering assembly, housing, and the sliding port block assembly.

The static mixing tube, manufactured by Semco, Inc., consists of a series of Teflon® elements inside a Delrin plastic tube. It derives its name from the fact that no moving parts are required to mix the epoxy. As the epoxy is injected into the forward end of the static mixing tube, the flow is divided by the first Teflon® element into four separate streams. These streams are channeled through the mixing element to outlet holes, which are offset by 90 degrees from the inlet holes. At this point, the streams exit into a small cavity between elements called the mixing chamber. Here the four streams intermingle before repeating the sequence through the next element at another 90-degree rotation. The epoxy streams are mixed seven times in this manner before exiting the static mixing tube.

The ram-controlled metering assembly consists of two stainless steel plunger rods connected to a double-acting pneumatic ram. It pushes the epoxy out of the cartridge, through the static mixing tube, and out the nozzle extension in

the required ratio of resin to hardener (1:1). The ram is manufactured by Bimba Manufacturing, Inc., Monee, Ill.

The housing consists of the cartridge retaining tubes, the supporting framework, and the trigger-handle mechanism. The retaining tubes are manufactured by Semco out of spun aluminum and are sized to accept the 20-fluid-ounce size Semco plastic cartridges. Both retaining tubes are attached by a continuous stainless steel hinge to the supporting framework. The framework and trigger handle mechanism are fabricated from 6061-T6 aluminum. The trigger-handle mechanism provides the on/off control of the tool.

The sliding porting block assembly consists of the porting block, the end block and the cam lever arm. Each epoxy component flows from its separate cartridge through the porting block to the inlet of the static mixing tube. Neoprene O-rings seal the nipple of the cartridge and inlet to the porting block. Rotation of the cam lever arm causes the porting block to slide back and forth over the end block. When pulled back, the porting block slides free of the cartridges, allowing the retaining tubes to rotate about their hinge point. This allows for quick and easy reloading of the epoxy cartridges. Both the porting block and the end block are made of Delrin plastic. The cam lever is made of aluminum.

The pneumatic circuit operates as follows: supply air enters an inlet at the trigger-handle mechanism or activation control valve. The activation control valve then directs the flow of air to another two-way valve that controls the travel direction of the ram. This valve is also manufactured by Bimba. An air line from the exhaust line to the rear of the mixing tube is used to blow the epoxy out of the mixing tube, thus preventing the mixed epoxy from hardening in the tool between grouting cycles. A manual ball valve (called the blow-out valve) controls this process.

ENVIRONMENTAL CONSIDERATIONS: The Sikadur Hi-Mod epoxy, which was tested for this grout-dispensing system consists of two parts: the vehicle (Part A), a bisphenol A type epoxy resin; and the catalyst (Part B), which contains a mixture of complex alkaline amines. The hazardous amines contained in Part B can cause severe burns. Thus, prolonged and repeated contact of either component with the skin should be avoided. Outside the water, it is recommended that respiratory protection (i.e., organic particle canister masks) be used and that all work be conducted in well-ventilated areas. Epoxy discharged during the blow-out sequences (if not positively contained) can cloud a small enclosed or poorly circulated working area. Whether these increases will result in an unacceptable water quality or other undesirable environmental consequences should be evaluated on a project specific basis. Variables that influence the nature and magnitude of any impacts include, but may not be limited to: the hydrodynamic setting, the physical and chemical characteristics of the grout used, and the regulatory environment. Personnel familiar with the evaluating water quality impacts of construction operations should be consulted during the early stages of project planning to ensure that appropriate water quality criteria and other environmental regulations will be met.

PRODUCT AVAILABILITY: The dispenser is available through the U.S. Navy's Ocean Construction Equipment Inventory, St. Juliens Creek Annex, Norfolk, VA, telephone (804) 485-6403.

REFERENCE: Thompson, H. and Middleton, L. 1984 (May). "Diver-Operated Grout Dispenser," TN N-1697, Naval Civil Engineering Laboratory, Port Hueneme, CA.